EP 1.89/2:M
58/7

READEX

US GOVERNMENT PUBLICATIONS (depository)
Environmental Protection Agency
A microprocessor ASCII character buffering
system 1982

Mar 83-7169
1 of 1
p.0001-0007

M 58/7

United States
Environmental Protection
Agency

Environmental Monitoring and Support
Laboratory
Cincinnati OH 45268

Research and Development

EPA-600/S4-82-051 Sept. 1982

EPA

Project Summary

A Microprocessor ASCII Character Buffering System

John M. Teuschler, Roger A Jollis, and Jonathan E. Kopke

NEWARK PUBLIC LIBRARY

NOV 18 1982

U. S. GOVT. PUBS.
DEPOSITORY 376

A microprocessor buffering system (MBS) was developed at the Environmental Monitoring and Support Laboratory — Cincinnati (EMSL-CI) to provide an efficient transfer of serial American Standard Code for Information Interchange (ASCII) information between intelligent instrument systems and a Data General NOVA laboratory automation computer system. Since the MBS is field programmable, the design is expected to satisfy many of the Agency's needs to transfer data from "intelligent instrument" computer systems to the standard EPA laboratory automation system. The system has the capability of transferring information simultaneously from three intelligent instrument systems.

This Project Summary was developed by EPA's Environmental Monitoring and Support Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The MBS is programmed to store in random access memory any "software flagged" serial data appearing on any one of three universal asynchronous receiver/transmitter (UART) ports. The data are collected until a preprogrammed software flag is received. The cease in data collection triggers the MBS to log into the NOVA system as a BASIC user. A BASIC program is then used by the NOVA to accept the data from the MBS and transfer them to a disk file. Once the data have been completely transferred, the MBS logs off the NOVA system, thereby freeing the port for another BASIC user. This microprocessor mode of transfer completely eliminates any manual intervention. With the data on the NOVA system, the "intelligent instrument" operator can then access the transferred data through the multi-user BASIC terminals and do further data reduction/manipulation on the transferred data in a high level language.

Once the data are on the NOVA system, processed data can be directly transmitted to data management/sample tracking computer systems or archived on magnetic tape.

Background

Figure 1 illustrates a mid 1970's lab automation system used to automate several EPA environmental monitoring laboratories. This medium scale integration Data General NOVA computer system was designed to collect data directly from the instruments utilizing Data General's multi-user, extended BASIC language, with calls to assembly language subroutines. Atomic absorption units, continuous flow analyzers, ultraviolet-visible spectrophotometers, emission spectrometers, and electronic balances are among the instrumentation interfaced to the system. The system has been used since 1975 to collect real-time data, process the raw data in extended BASIC, and produce final output reports.

Further, the laboratory automation system has the capability of being included in a hierarchical computer network through the synchronous line adapter (SLA). Thus, laboratory data can

EP1.89/2:

READEX FICHE

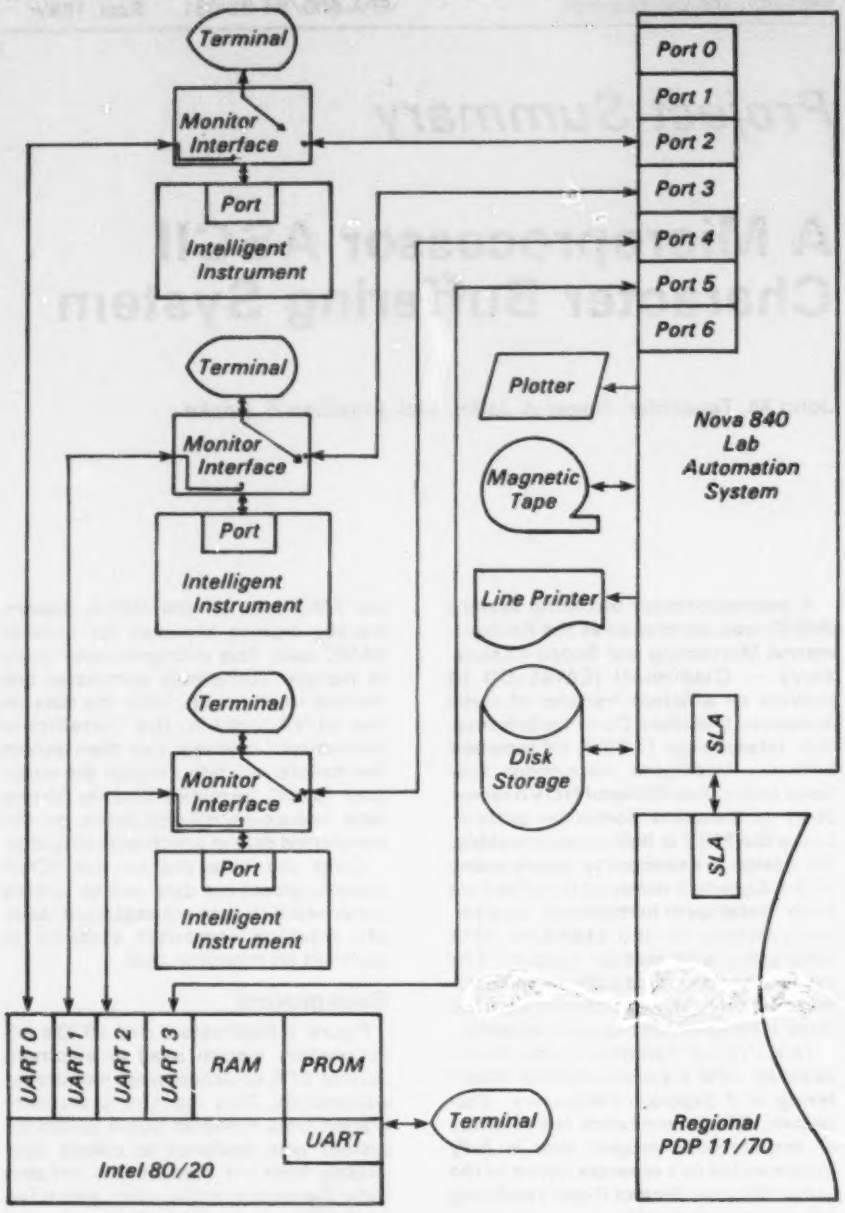

Figure 1. *Microprocessor buffer system.*

be transferred to larger data base management computers in general, and to the EPA Sample File Control System specifically. Standard software is purchased to drive the SLA hardware. The Houston Attached Support Processor (HASP) software or 2780 emulator software is available for use on the NOVA. Since the NOVA system was specified with two programming grounds, this allows multi-user BASIC, which interfaces to the instrumentation, to run in the foreground, while the background is used for system functions and communications, thereby supplying the link to the next computer. Consequently, the system offers a relatively easy-to-use, high level language for the processsing of laboratory data.

Users of commercial instrument systems, such as the Jarrell-Ash inductively coupled argon plasma emission spectrometer and the Varian gas chromatography data system, recognized the capabilities of the NOVA laboratory automation system and desired a data link from their systems to the NOVA. Primordial attempts at such a data link usually consisted of carrying punched paper tape to the NOVA. Besides being cumbersome for the operator, the approach was slow and the system console had to be utilized to read the tapes and transfer the data to a disk file. A better solution was needed.

Microprocessor Buffer System (MBS)

The MBS was designed to function as a front end processor for the NOVA. Data are buffered in the MBS and retransmitted to the NOVA via a BASIC user port. As such, the MBS must provide real-time capture of ASCII codes for processors attempting to communicate with the NOVA. It must also provide random access memory (RAM) for the buffering of the information to the NOVA system, and read only memory (ROM) to contain the programming instructions.

Figure 1 is a block diagram of the MBS. Real-time data acquisition of ASCII codes is accomplished by the control and manipulation of universal asynchronous receiver/transmitters (UARTS). A UART is a device which is used for data transmission. Parallel data is converted to serial data by the UART and is transmitted down a line. Likewise, serial data from another system is received by the UART (a character at a time), converted to parallel data, and placed on the bus of a computer.

A set of information uses at least one memory block. The total number of memory blocks used for a set is only limited by the memory buffer size of the MBS. Similarly, the memory size is the only limitation on the number of sets of information contained in the memory buffer. A set of information is not transmitted to the NOVA until the complete set is received (starting, stopping, and terminating characters).

Real-Time Acquisition of ASCII Characters

Each instrument has a dedicated port (UART) hardwired to the output of the intelligent instrument's micro/minicomputer. Immediately upon reception of an ASCII character, the UART interrupts the MBS so that the character can be processed. If the character is to be stored, it is written into the memory of the MBS.

The MBS can receive simultaneous data from the three intelligent instruments at individual data rates of up to 1200 baud. Every character generated by the intelligent instruments is received, processed, ignored, or stored, if the action is warranted. The MBS continuously monitors the outputs of the intelligent instruments through the incorporation of the dedicated interrupt generating UARTs.

Data Discrimination

Not all data are to be buffered and transmitted to the NOVA. Since the MBS monitors all transmissions from the intelligent instruments, a special pre-programmed sequence of ASCII characters is used to start and stop the data buffering action. At system initialization, the MBS is programmed "on-site" for individual starting and stopping characters for each of the three intelligent instruments. A sequence of five characters is utilized as the triggering mechanism for the start-buffering and stop-buffering action. Likewise, the MBS is programmed "on-site" so that each intelligent instrument has a particular directory on the NOVA system into which the data will be transferred.

Software discrimination works well for normal circumstances. However, during testing and start-up procedures for the intelligent instruments, the five starting characters may inadvertently be output. Therefore, a hardware switching function was included on the interface boxes at the intelligent instrument sites to allow the operator to disconnect the instrument. Thus, the operator can disable the transmission of ASCII characters to the MBS, make several tests to ascertain instrument validity, and then enable the transmission, thereby allowing valid information to be buffered by the MBS.

Data Storage

The MBS can be configured with up to 48,000 bytes of memory buffer area. The system will automatically determine the size of its own memory and divide it into 1000-byte blocks. A dynamic memory allocation scheme is used to select blocks of available memory for buffering data. The memory blocks are used as they are needed. As the buffered data are transferred to the NOVA, the blocks are again placed in the free block pool. If the last free block of memory is used, a signal is sent to the operator to alert him of the situation. A hardware signal is also sent to the monitor interface boxes (see Figure1) to prevent any further transmissions from the intelligent instruments until the problem is resolved.

The data can be stored indefinitely in the MBS. Data can only be removed from the MBS by an organized transfer of the information to the NOVA or a complete MBS re-initialization (e.g., power down). The MBS buffers sets of information. A set begins with the five starting characters and includes all the following ASCII characters. The set terminates with the carriage return following the five stopping characters.

Data Transmission

The MBS was designed to mimic a human user and enter the data through a BASIC language user port. This mode of transferring the data through a high level language user port placed the least burden on the NOVA system.

The choice of a BASIC language program in the NOVA to receive communications from the MBS was made due to the relative stability of the high level programming language. Data general and other manufacturers are constantly revising and improving the operating system software. This continuous state of flux makes it extremely difficult to utilize assembly code modules to interface the instrument systems and analog instruments. Therefore, this interface was designed in a manner which does not rely on the revision stability of Data General software. By interfacing at a BASIC user port, software maintenance between operating revisions will be minimized.

Logon

Upon reception of a complete set of information, a NOVA logon task is activated in the MBS. UART #3 will send an "escape" character to the NOVA. The port on the NOVA will respond according to the present activity on the port. The MBS system has been programmed to handle any possible combination of responses the NOVA can generate.

Since the logon task is activated by the complete reception of a set of data, the set of data has a particular account identification associated with it. Part of the logon task is to correctly log into the appropriate account so as to allow the transfer of information into the proper NOVA directory. Any problems in logon will cause an error status light to be activated at the monitor interface boxes as well as at the MBS console. This will alert an operator to a potential data transmission problem. As long as remedial action is taken upon observance of the error status light, the MBS should never be in a situation where the memory of the system has been completely filled.

Data Transmission Error Conditions

Since the MBS is transferring information via the BASIC language, as a character is transmitted to the NOVA, the NOVA responds with an echo. The echo from the NOVA is compared by the MBS to the character which was sent; if the two characters agree, the next character is sent. If for some reason there was a data transmission problem and the wrong character was echoed, the MBS transmits a "delete" character. Basic responds with an underscore character upon reception of a delete character. The MBS system will again attempt to transmit the original character. This design prevents erroneous characters from being stored in the NOVA.

If for some reason there is no response from the NOVA in a reasonable time, the MBS will terminate any further character transmissions and start over with the logon procedure. The MBS will again attempt to transfer the entire set of information to the NOVA.

Characters which cause problems with the BASIC language are prefiltered and transmitted as their ASCII decimal equivalents (See Appendix E, Data General *Extended BASIC User's Manual*, Rev. 06). Commas, spaces, and escape characters are among the characters which are transformed into their decimal equivalents before transmission to the NOVA.

Log Off

Upon complete transmission of a set of data to the NOVA, the MBS will send an escape character to terminate the data transfer program. When the NOVA responds with an asterisk (this signals that BASIC is in the command mode), the MBS will log off from the NOVA, thereby freeing the NOVA port for another foreground BASIC user.

System Status

The console CRT displays the status of each intelligent instrument and of the MBS system as a whole, as shown in Figure 2. An intelligent instrument system may be ready, receiving infor-

mation, transmitting information, or in the process of holding a complete set of information in the memory buffer (standby). Error conditions are also indicated on the system console.

The monitor interface box at the intelligent instrument site also indicates the status of the system for the individual site. An operator should observe the status indicator on the monitor interface change from "ready" to "receiving" when the instrument system transmits the five-character starting sequence to the MBS. The monitor interface will remain in this state until the five stopping characters are received along with the terminating carriage return. At this point, the status of the monitor interface will indicate "standby." The "ready" indicator will also appear, indicating the MBS is again ready for another set of information. The "transmitting" status indicator on the monitor interface will be active only when the MBS is in the process of sending the set of information to the NOVA. Note that it is possible to have several status indicators active at the same time on the monitor interface.

Environmental Monitoring and Support Laboratory - Cincinnati
Advanced Instrumentation Section

Microprocessor Buffer System
Version 2.1

	User 0	User 1	User 2	
uP READY	•	•		
Up RCVG			•	*System Running Normally*
uP STBY		•		*Blocks in Use: 05*
uP TRANS			•	*Buffer Size: 48 Blocks*

Figure 2. MBS status display.

Hardware Implementation

Intel Corporation hardware was chosen for the implementation of the MBS because it was exceptionally strong in both software and hardware support. Since software development is a major consideration of any microprocessor project, the software tools available on the MBS system significantly biased the selection of the hardware vendor. Intel Corporation also provided "off the shelf" hardware modules for an assortment of hardware functions. The selection of Intel products satisfied the "commercial availability" aspect of the project objectives.

System Hardware (Mainframe and CPU)

The specific hardware for the project consists of an SBC 80/20-4 system. The system is a four-slot chassis with eight-level interrupt capability. The four slots are occupied with a central processing unit (CPU) card, a communications card, and additional RAM cards. The system is available in a standard 19-inch rack mount chassis, which allows the MBS to be mounted in the 19-inch rack mounts containing the Data General NOVA equipment. The CPU card for the system was a SBC 80/20-4. The board has the capacity for up to 8192 bytes of ROM and 4096 bytes of RAM. Jumper configurations for the CPU card can be obtained in Appendix A of the full report.

The programmable asynchronous RS232C serial interface on the board functions as the connection to the initializing and diagnostic console. The CPU card has the eight-level programmable interrupt control capability necessary to accommodate the real-time data acquisition of ASCII characters function, which receives simultaneous serial ASCII transmissions from several intelligent instruments. More detailed information can be obtained from the "SBC 80/20-4 Microcomputer Hardware Reference Manual," available from Intel Corporation.

Communications

A four-channel communication expansion board (iSBC 534) was selected as the means to get serial ASCII data into the MBS. The board has individual software programmable baud rate generation for each serial input/output (I/O) channel. This feature allows the field selection of communication rates to meet the varying baud rate needs of the instruments. When the system is initialized in the field, the operator has the option of selecting the individual baud rates of the three incoming ASCII character transmissions from the instrument systems. The operator can also select the baud rate the microcomputer will use to communicate the information to the NOVA.

The SBC 534 card has the capability of operating with priority encoded and programmable interrupt algorithms. This feature allows the 534 card to interrupt the CPU whenever a characer has been received from any of the intelligent instruments. This is accomplished by strapping the 534 card to allow an interrupt to take place whenever there is a "received character" flag on any of the three UARTs continuously monitoring the intelligent instruments. To prevent one intelligent instrument from monopolizing the MBS, the three intelligent instruments are placed in an auto-rotating interrupt arrangement. This arrangement gives equal priority to all interruptors. Each interruptor, after receiving service, becomes the lowest priority level until the next interrupt occurs. This rotating priority mode ensures the processing of all the characters as they are received by the UARTs. Three of the four UARTs on the SBC 534 card are used to continuously monitor the intelligent instruments. The fourth UART is used to communicate with the NOVA. For more detailed information on the communications card, consult the "iSBC534 Four Channel Communications Board Hardware Reference Manual" from Intel Corporation.

Memory

The CPU card has the capability of holding 8192 bytes of programmable read only memory (PROM). Of the 8192 bytes, 5262 bytes were used for the MBS. There is also an additional 4096 bytes of RAM resident on the CPU card. The CPU RAM is used for the storage of the stack, the interrupt jump table, and utility storage for the MBS. The CPU card contains all the necessary memory resources required for system operation. Therefore, the additional expansion memory boards, which are plugged into the remaining two slots of the SBC 80/20-4 system, are used for storage of buffered data.

The memory used for buffering data is blocked into 1000-byte blocks at system initialization time. Therefore, a single 16K byte RAM card can be used for buffer memory, or a combination of a 16K byte and a 32K byte memory card can be used together, giving 48K bytes of storage for the buffered data. Since

the system is auto-sizing, the amount of memory to be used to buffer the data is automatically found and blocked at system initialization.

Diagnostic Terminal

A Hewlett Packard 2640 terminal was utilized for the "on line" display of the communication buffering system. The status of the system is displayed on the terminal in real-time. This particular terminal was selected primarily because it is common in EPA laboratories. The display dynamically depicts the status of User 0, User 1, and User 2. The users can be active in any of four states. Referring to Figure 2, the "uP READY" mode corresponds to a condition that exists when the MBS is still waiting to receive the five starting character sequence for the particular user. "uP RCVG" mode is active when the associated user is sending a set of data to the MBS. When the five stopping characters and the terminating carriage return are received, the status changes to "uP STBY," signifying that a set of data has been buffered and is awaiting transfer to the NOVA system. If the system is presently transferring information to the NOVA, the "uP TRANS" mode will be active. The only two mutually exclusive modes are the uP READY and the uP RCVG. All other modes may be displayed in combination with each other.

The particular display shown in Figure 2 has a present status of:

- User 0 is waiting to receive the starting characters,
- User 1 is waiting to receive the starting characters, and a set of data is awaiting transmission to the NOVA.
- User 2 is in the midst of receiving a set of data, and a previously stored report is presently being transmitted to the NOVA.

Besides displaying the status of the users, the display gives an indication as to the overall status of the MBS. The message "SYSTEM RUNNING NORMALLY" will change to reflect any abnormal condition the MBS encounters. A audible alarm will also be sounded to alert an operator in the computer room. Typical abnormal displays include "NOVA NOT RESPONDING," and "MAX USERS OR ALL LINES BUSY." The operator is thereby made aware of the problem and may take corrective action if it is necessary.

The memory buffer size is also displayed on the console. In Figure 2 it is shown as 48 blocks. This corresponds to a 48K byte memory buffer size. A "blocks in use" count is also displayed to give the operator an idea of the amount of memory typically in use during the normal operation of the system.

Custom Hardware

Communication between the MBS and the intelligent instrument is void of human intervention, however, a monitor interface box was designed to allow the instrument operator to be aware of the status of the communications. The MBS automatically updates status lights on this box at two-second intervals in the quiescent state.

The conditions displayed are shown in Figure 3. Figure 4 is a block diagram of the monitor interface box. Under the STATUS DISPLAY section of the interface, there are six separate functions which can be independently displayed: ready, receiving, standby, transmitting, error, and stop data. The ready function indicates that the MBS is ready to receive the starting characters which initialize the buffering action. The receiving function indicates that the MBS has received the starting characters and is now buffering the information in the RAM of the buffer system. The standby function signifies that a total report has been buffered; that is, the starting characters, stopping characters, and terminating carriage return have been received, and the information contained in the set has been stored in the memory and is awaiting transfer to the NOVA. The transmitting function is activated when the MBS has established communications with the NOVA and is proceeding with the transfer of information. The error function will occur if there is any problem with establishing communications with the NOVA. If this display occurs, the operator should immediately contact the system manager to ascertain the cause of the problem. The stop data function occurs when there is no longer a free block of RAM. This function signals the intelligent instrument operator to stop any further trans-

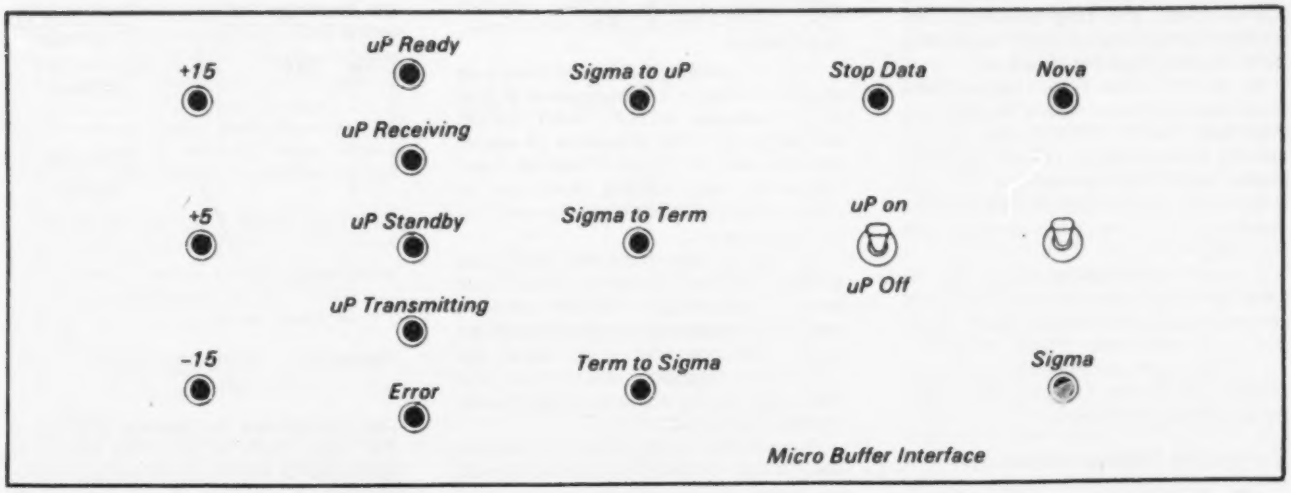

Figure 3. *Front panel of monitor interface.*

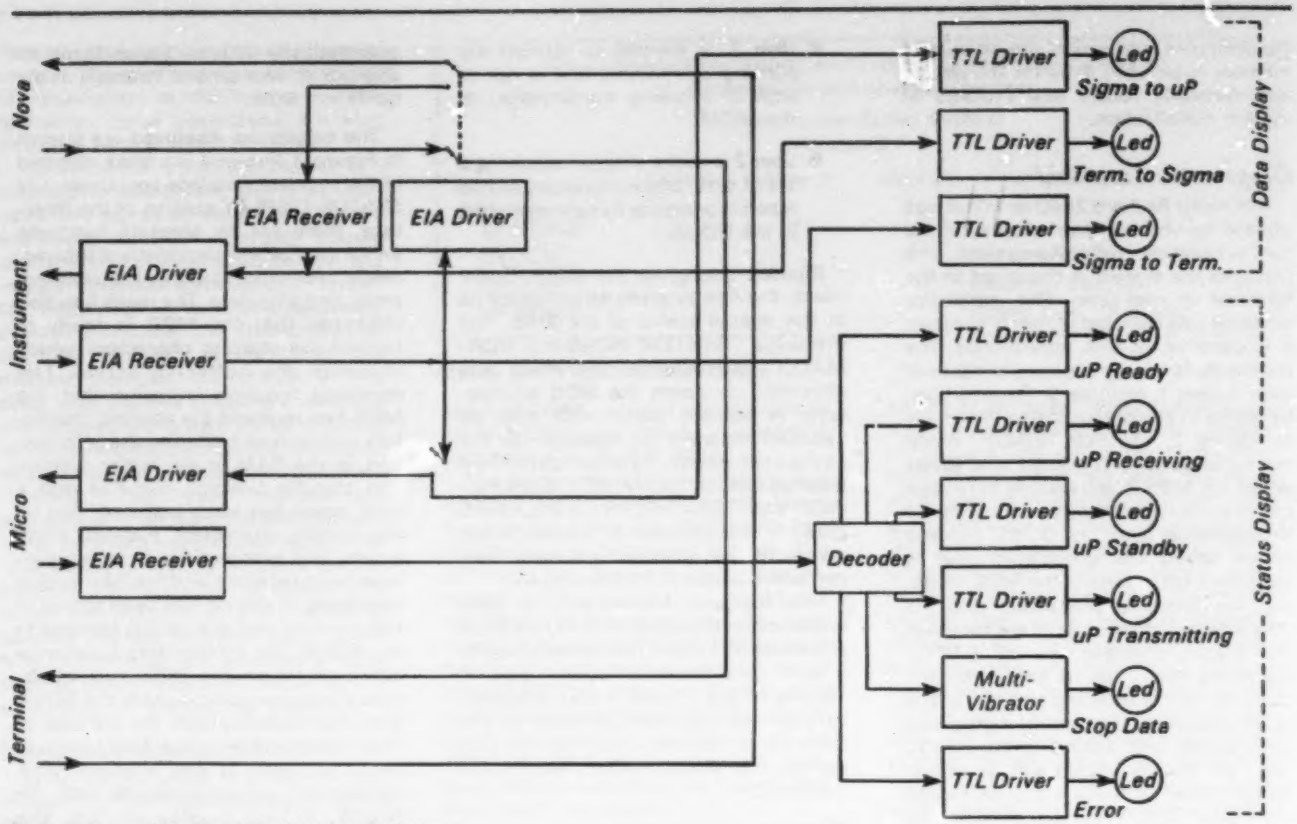

Figure 4. *Monitor interface block diagram.*

missions of information. The stop data function only occurs if all the RAM has been filled. The function not only displays the information but also drops the "request to send" flag going to the intelligent instrument. In instruments where the feature is installed and operational, this flag prevents any further transmissions from emanating from the intelligent instrument.

As can be seen from Figure 4, the block diagram, the status display is a decoded EIA-RS-232C transmission coming from the MBS. Further, the data display section of the interface indicates a transfer of information between the intelligent instrument, the terminal, and the MBS.

A switch was incorporated into the interface to allow the terminal to communicate with the intelligent instrument or with the NOVA. Another switching arrangement was installed to disable transmissions going to the MBS, as described previously.

Software Implementation

The software of the MBS can be separated into two main divisions: the non-interrupt driven software and the interrupt driven (real-time) software. The real-time software receives all the information being transmitted to the MBS and this function is its the highest priority operational task.

Non-Interrupt Driven Software

The non-interrupt driven software as shown in Figure 5 is composed of four main modules: SETUP, WAIT, OPER, and NOVAST. The sequence of operations shown in Figure 5 can be interrupted at any instant, and can be resumed without affecting the integrity of the system.

As can be seen from the figure, the module "SETUP" is only activated upon system initialization. SETUP contains the field programmable features of the MBS. The operator must input the "software flagged" information the MBS will use to activate its store-and-forward features.

The software flags allow the MBS to discriminate between data which should be stored versus data which should be ignored. Five starting characters are

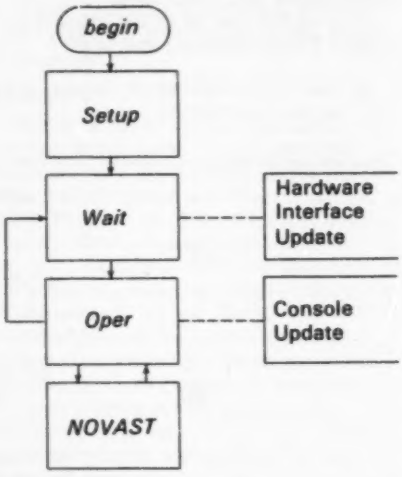

Figure 5. *Non-interrupt driver software.*

used to activate the storage feature of the MBS. Each of the three programmable ports which continuously monitor the intelligent instruments has individually programmed starting char-

acters. Similarly, five stopping characters are input during the SETUP module for each of the individually programmed input ports. Additionally, each port has a separate NOVA account into which the data will be transferred. When the MBS logs into the Data General multi-user BASIC system, the NOVA asks for the account (specific disk directory) the user wishes to log into. This accounting information is distinct for each of the three ports. In the MBS, this information is stored as a sequence of four characters.

The last of the four programmable features to be input during the SETUP module is the baud rate which is programmed for each intelligent instrument port, including the NOVA port, but excluding the console port. Baud rate choices are limited to 110, 300, and 1200. All of the field programmability of the MBS is accomplished during the execution of the SETUP module, which is responsible for the initialization of the programmable interrupt controllers, programmable timers (baud rate generators), and programmable UARTs.

During SETUP, the memory of the MBS is polled to determine its size. The existing memory is then divided into 1000-byte blocks for use in the buffering operations.

In Figure 5, the WAIT-OPER-NOVAST loop is the lowest priority operation of the system. After the SETUP module has been executed, the WAIT module updates the hardware interface status information approximately every two seconds. The WAIT module then calls the OPER module. The OPER module updates the diagostic console, which is displaying the real-time status of the MBS on a Hewlett Packard 2640 series terminal. During the console update, the NOVAST module is called at approximately 120-times-per-second. It is essentially a typist that logs into the NOVA, types a buffered report into a disk file on the NOVA, and then logs off the NOVA.

When the NOVAST module is called, it may perform one of several functions:

- Check to see if a report is pending for transmission to the NOVA;
- continue sending a report to the NOVA;
- continue logging onto the NOVA;
- continue logging off from the NOVA.

The NOVAST module is not interrupt driven. It mimics a human BASIC user on the NOVA. The NOVAST module *will* unmask the NOVA interrupt handler to enable the MBS to receive in real-time a character from the NOVA whenever a character is due to be transmitted. In so doing, the NOVA interrupt handler ensures the MBS will receive any transmission from the NOVA.

The NOVAST module is programmed to respond to any foreseeable NOVA response and works in close conjunction with the NOVA interrupt handler routine. It will send a transmission (ASCII character) to the NOVA, and will activate the NOVA interrupt handler so that the echoed character can be received and checked against the transmitted character. If the characters do not match, a delete character is transmitted to the NOVA, and the correct character is again transmitted to the NOVA.

The MBS is programmed to recover from any type of transmission failure to the NOVA. If at any time during the transmission of a report to the NOVA, the NOVA fails to respond properly, the MBS attempts to correct the malfunction; if all else fails, the MBS will reinitiate the login procedure and retransmit the report to the NOVA. Even catastrophic failures such as the NOVA being down were accounted for. The MBS simply attempts to log into the NOVA at two-minute intervals until the NOVA responds to the log in attempts.

Real-Time Software

The interrupt driven portion of the MBS is shown in Figure 6. Module TB534 determines which UART has interrupted the microprocessor and directs the program flow to the appropriate vectored interrupt module. The modules USER0, USER1, and USER2 control the interpretation of the software flags which determine the store-and-forward features of the system. The three modules operate totally independently of each other. For example, USER0 can be attempting to identify the starting sequence characters while USER2 may be storing the third 1000-byte block of buffered information.

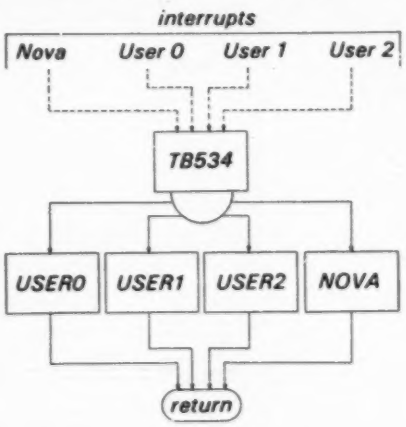

Figure 6. *Interrupt driven software.*

FRESH is the module which allocates the memory blocks to the appropriate users. Memory is dynamically allocated to the users. As a block is freed, it is immediately placed in the free block pool. If the FRESH module cannot locate a free block, the MBS immediately halts further characters from being sent to it by dropping the "request to send" flags. In more advanced intelligent instrument systems, the dropping of this flag inhibits their further transmission of data. FRESH also causes an alarm to be sent to the hardware interfaces at the intelligent instruments, thereby alerting the operators of the condition present. As the NOVAST module transmits buffered information to the NOVA, the memory blocks will be freed, and the FRESH module will allow resumption of the data transfer to the MBS.

The NOVA interrupt handler is responsible for receiving and appropriately handling the information being transmitted to the MBS by the NOVA. The NOVA interrupt handler has multiple functions controlled by the NOINST (NOVA interrupt status) flag, but may process only one character. This is the procedure followed when the buffered data are being transferred to the NOVA and a character echo check is being imposed on the system. The handler may instead process a sequence of ASCII information being transmitted to the MBS. This type of action is necessary when the NOVA responds to the MBS logging into the NOVA. That is, when the MBS sends an escape character, the NOVA may respond with the sequence "ACCOUNT ID:" or "ALL LINES BUSY." The NOVA interrupt handler will appropriately respond with the correct course of action.

The NOVA interrupt handler and the NOVAST module operate in close association with each other (See Figure 6). The combination of these two modules totally simulates a 120-character-per-second human typist.

Instruments with which this system has been used include the Perkin-Elmer Sigma 10, the Finnigan INCOS GC/MS system, the Varian 620L GC system, and the Jarrell Ash Inductively Coupled Argon Plasma (ICAP) system.

*USGPO: 1982 — 559-092/0509

*The EPA authors **John M. Teuschler** (EPA contact, see below) and **Roger A. Jollis** are with the Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268; Jonathan E. Kopke is with the University of Cincinnati Computing Center, Cincinnati, OH 45220.*

The complete report, entitled "A Microprocessor ASCII Character Buffering System," (Order No. PB 82-242 074; Cost: $13.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

***John M. Teuschler** can be contacted at:*
Environmental Monitoring and Support Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

Postage and
Fees Paid
Environmental
Protection
Agency
EPA 335

Official Business
Penalty for Private Use $300